CLAIMS

What is claimed is:

1. A valve assembly comprising a valve body with an inlet and an outlet port, a partition wall having a valve seat separating said valve body into a first flow passage and a second flow passage; a piston, having a throughbore including an orifice, reciprocably mounted in said valve body, said piston being gradually movable between a first position and a second position; a modulating plug in conjoining contact with said piston, reciprocably mounted in said valve body and gradually movable between an open position, permitting fluid flow from said first flow passage to said second flow passage, and a closed position engaging said valve seat, blocking fluid flow from said first flow passage to said second flow passage; and a valve cover adjoining said valve body;

wherein the improvement comprises a throttling member connected with said valve cover and extending into said throughbore and said orifice, adapted to insure a gradual alteration of the cross-sectional area of said orifice upon reciprocation of said piston between said first and second positions.

2. The valve assembly as in claim 1 wherein said valve cover has a throughbore, for receiving a pilot fluid flow, aligned with said piston throughbore.

3. The valve assembly as in claim 1 wherein said valve body has a connecting passage leading from said first flow passage to a gap between said valve body and said valve cover.

4. The valve assembly as in claim 1 wherein said gradual alteration of the cross-sectional area of said piston orifice is proportional to the volume of a pilot fluid flow passing through said orifice in said piston.

5. The valve assembly as in claim 1 wherein said gradual alteration of the cross-sectional area of said piston orifice is accompanied by a gradual movement of said modulating plug between said opening position and said closed position.

6. The valve assembly as in claim 1 wherein the cross-sectional area of said piston orifice changes for each position of said piston between said first and said second positions.

7. The valve assembly as in claim 1 wherein the permissible volume of a pilot fluid flow changes with each position of said piston between said first and said second positions.

8. The valve assembly as in claim 1 wherein at said piston first position, said piston orifice is substantially fully closed, and in said second position said piston orifice is in its maximum open position.

9. The valve assembly as in claim 2 wherein said valve cover throughbore includes a passage for directing pilot fluid flow into said piston throughbore.

10. The valve assembly as in claim 1 wherein said throttling member is a tapered pin which is received within said piston throughbore.

11. The valve assembly as in claim 1 wherein said throttling member is a pin having a cross-sectional area that gradually decreases from its top to its bottom.

12. The valve assembly as in claim 1 wherein said throttling member is a fixed disk of a predetermined size which is received within said piston throughbore and said piston throughbore has a cross-sectional area that gradually increases from a first end to a second end.

13. A valve assembly comprising:

a valve body with an inlet and an outlet port having a partition wall with a valve seat separating said valve body into a first flow passage and a second flow passage;

a piston, having a throughbore including an orifice, reciprocably mounted in said valve body and movable between a first position and a second position;

a modulating plug in abutting contact with said piston, reciprocably mounted in said valve body and gradually movable between an open position, permitting fluid flow from said first flow passage to said second flow passage, and a closed position engaging said valve seat, blocking fluid flow from said first flow passage to said second flow passage;

a valve cover adjoining said valve body; and

a throttling member, connected to said valve cover and extending into said throughbore and through said orifice, adapted to insure a gradual alteration of the cross-section of said piston orifice upon reciprocation of said piston between said first and second positions.

14. The valve assembly as in claim 13 wherein said valve cover has a throughbore, for receiving a pilot fluid flow, aligned with said piston throughbore.

15. The valve assembly as in claim 13 wherein said valve body has a connecting passage leading from said first flow passage to a gap between said valve body and said valve cover.

16. The valve assembly as in claim 13 wherein said gradual alteration of the cross-section of said piston orifice provides a gradual movement of said modulating plug between said opening position and said closed position.

17. The valve assembly as in claim 13 wherein the cross-section of said piston orifice changes for each position of said piston between said first and said second position.

18. The valve assembly as in claim 13 wherein the permissible volume of a pilot fluid flow changes with each position of said piston between said first and said second position.

19. The valve assembly as in claim 13 wherein said throttling member is a tapered pin which is received within said piston throughbore.

20. The valve assembly as in claim 13 wherein said gradual alteration of the cross-sectional area of said piston orifice is proportional to the volume of said pilot flow passing through said piston orifice.

21. The valve assembly as in claim 13 wherein said gradual alteration of the cross-sectional area of said piston orifice changes with the travel of said piston.

22. The valve assembly as in claim 13 wherein said gradual alteration of the cross-sectional area of said piston is linear.

23. The valve assembly as in claim 13 wherein said gradual alteration of the cross-sectional area of said piston is non-linear.

24. The valve assembly as in claim 13 wherein at said piston first position, said piston orifice is substantially fully closed and in said second position said piston orifice is in its maximum open position.

25. The valve assembly as in claim 13 wherein said throttling member has a cross-sectional area that gradually decreases from a first end to a second end.

26. The valve assembly as in claim 13 wherein said throttling member is a fixed disk of a predetermined size which is received within said piston throughbore and said piston

throughbore has a cross-sectional area that gradually increases from a first end to a second end.

27. A method of gradually opening a modulating plug of a valve assembly, said valve assembly including a valve body having a main fluid flow passage extending therethrough, a valve cover, a throttling member connected to said valve cover, a reciprocable piston having a throughbore including an orifice, which receives said throttling member therethrough, said modulating plug having an upper end in abutting contact with said piston, said method comprising the steps of:

a. directing a flow of pilot fluid into a restricted gap adjoining an outer end of said piston;

b. increasing said pilot fluid forces on a first end of said piston, gradually moving said piston and said modulating plug, reciprocably mounted in said valve body, between a first position and a second position, wherein said first position includes having said throttling member substantially closing said throughbore piston orifice;

c. equalizing the forces acting upon said modulating plug;

d. gradually increasing the pilot fluid flow forces indirectly acting upon the upper end of said modulating plug such that said modulating plug gradually moves to a fully opened position; and

e. gradually opening said main fluid flow passage within said valve body.

28. The method as in claim 27 wherein the step of gradually increasing the forces comprises increasing the amount of fluid flow passing through said piston orifice.

29. The method as in claim 27 wherein said modulating plug gradual movement is proportional to the volume of pilot fluid flow introduced to said valve assembly.

30. The method as in claim 27 wherein said gradual increase in pilot fluid forces indirectly acting upon the upper end of said modulating plug is a linear increase.

31. The method as in claim 27 wherein said equalization of fluid forces indirectly acting upon said modulating plug occurs substantially simultaneously with movement of said piston.

32. The method as in claim 27 wherein said equalization of fluid forces indirectly acting upon said modulating plug is reactive to an increase in forces acting upon said piston.

33. The method as in claim 27 wherein said gradual increase in pilot fluid force indirectly acting upon the upper end of said modulating plug is a non-linear increase.

34. A valve assembly comprising:

a valve body with an inlet and an outlet port having a partition wall with a valve seat separating said valve body into a first flow passage and a second flow passage;

a piston having a throughbore including an orifice, reciprocably mounted in said valve body and movable between a first position and a second position;

a modulating plug in abutting contact with said piston, reciprocably mounted in said valve body and movable between an open position, permitting fluid flow from said first flow passage to said second flow passage, and a closed position engaging said valve seat, blocking fluid flow from said first flow passage to said second flow passage;

a valve cover adjoining said valve body; and

a throttling member, connected to said valve cover, adapted to insure one of a linear and non-linear altering of said piston orifice cross-sectional area upon movement of said piston.

35. The valve assembly as in claim 34 wherein said valve cover has a throughbore, for receiving a pilot fluid flow, aligned with said piston throughbore.

36. The valve assembly as in claim 34 wherein said valve body has a connecting passage leading from said first flow passage to a restricted gap adjoining an outer end of said piston.

37. The valve assembly as in claim 34 wherein said throttling member is a pin, having various cross-sections that are separated with a plurality of steps, received by said piston throughbore.

38. The valve assembly as in claim 34 wherein said altering of the opening of said piston orifice cross-sectional area is substantially reactive to the volume of said pilot flow passing through said piston orifice.

39. The valve assembly as in claim 34 wherein in said piston first position, said piston orifice is substantially closed and in said second position said piston orifice is in its furthermost open position.

40. The valve assembly as in claim 34 wherein said modulating plug movement from said closed position to said open position is non-linear.

41. The valve assembly as in claim 34 wherein said modulating plug movement from said closed position to said open position is linear.